Seismic Safety of Palo Alto High School Buildings

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INTRODUCTION

Research Question: Are buildings at Palo Alto High School adequate in terms of seismic safety?

Palo Alto High School: Main Office

Using *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*, buildings at Palo Alto High School were visually screened to see if any are potentially hazardous.

Other information was obtained from building plans at the District Office.

BACKGROUND AND SIGNIFICANCE

Palo Alto High School is located in a region close to the San Andreas fault, a site prone to high seismicity. In the event of an earthquake, the seismic resistance of buildings on campus is extremely important for the safety of students and staff.

After the 1933 Long Beach earthquake, the urgency of having safer buildings, especially public school buildings, was brought into light. The Field Act, a legislation that requires a high standard of review during seismic design and construction of California public schools buildings, was passed a month after the Long Beach earthquake by the California legislature (Department of General Services, 2002). The Field Act was one of the earliest legislations to improve California public school buildings by calling for better seismic resistance.

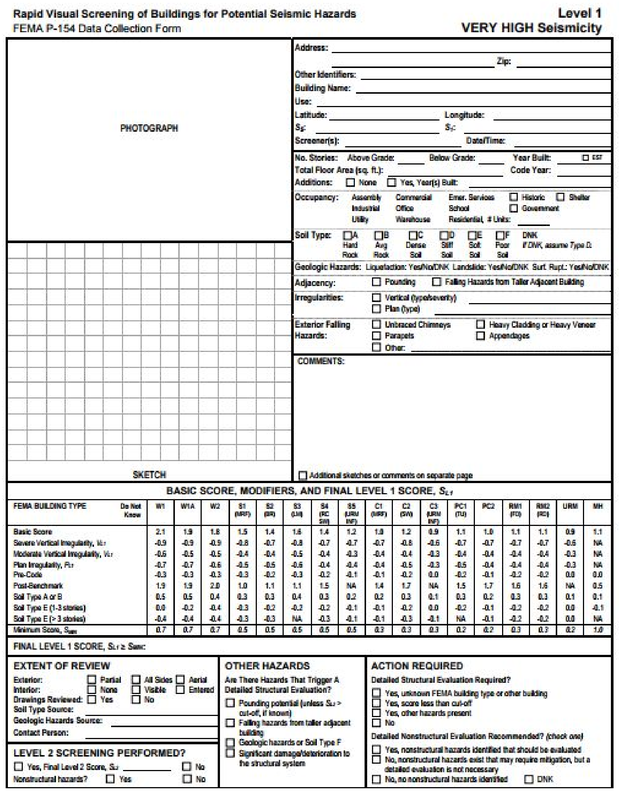
Palo Alto High School: Performing Arts Center

The 1906 San Francisco earthquake also created a prominent advance in building codes in America as it encouraged earthquake engineers to gain better understanding of effective earthquake safety standards (Cutcliffe, 2000).

The *Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook* guides the screener through the whole data collection form, and explains how to deduce the data collected (FEMA, 2016). This handbook is beneficial for schools that desire a quick and low cost way of detecting their building's seismic safety.

RESEARCH METHODOLOGIES

Data Collection Form



Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA P-154 Data Collection Form
Level 1
VERY HIGH Seismicity

PHOTOGRAPH

SKETCH

Address: Zip:
Other Identifiers:
Building Name:
Use:
Latitude: Longitude:
S_S: S_1:
Screener(s): Date/Time:
No. Stories: Above Grade: Below Grade: Year Built: ☐ est
Total Floor Area (sq. ft.): Code Year:
Additions: ☐ None ☐ Yes, Year(s) Built:
Occupancy: ☐ Assembly ☐ Industrial ☐ Utility ☐ Commercial ☐ Office ☐ Warehouse ☐ Emer. Services ☐ School ☐ Residential, # Units: ☐ Historic ☐ Shelter ☐ Government
Soil Type: ☐ A Hard Rock ☐ B Avg Rock ☐ C Dense Soil ☐ D Stiff Soil ☐ E Soft Soil ☐ F Poor Soil ☐ DNK If DNK, assume Type D.
Geologic Hazards: Liquefaction: Yes/No/DNK Landslide: Yes/No/DNK Surf. Rupt.: Yes/No/DNK
Adjacency: ☐ Pounding ☐ Falling Hazards from Taller Adjacent Building
Irregularities: ☐ Vertical (type/severity) ☐ Plan (type)
Exterior Falling Hazards: ☐ Unbraced Chimneys ☐ Parapets ☐ Other: ☐ Heavy Cladding or Heavy Veneer ☐ Appendages
COMMENTS:
☐ Additional sketches or comments on separate page

BASIC SCORE, MODIFIERS, AND FINAL LEVEL 1 SCORE, S_{L1}

FEMA BUILDING TYPE	Do Not Know	W1	W1A	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM	MH
Basic Score		2.1	1.9	1.8	1.5	1.4	1.6	1.4	1.2	1.8	1.2	0.9	1.1	1.0	1.1	1.1	0.9	1.1
Severe Vertical Irregularity, V_{IA}		-0.9	-0.9	-0.9	-0.8	-0.7	-0.8	-0.7	-0.7	-0.7	-0.6	-0.6	-0.7	-0.7	-0.7	-0.7	-0.6	NA
Moderate Vertical Irregularity, V_{IC}		-0.6	-0.5	-0.5	-0.4	-0.4	-0.5	-0.4	-0.3	-0.4	-0.4	-0.3	-0.4	-0.4	-0.4	-0.4	-0.3	NA
Plan Irregularity, P_{1X}		-0.7	-0.7	-0.6	-0.5	-0.5	-0.6	-0.4	-0.4	-0.4	-0.5	-0.3	-0.5	-0.4	-0.4	-0.4	-0.3	NA
Pre-Code		-0.3	-0.3	-0.3	-0.3	-0.2	-0.3	-0.2	-0.1	-0.1	-0.2	0.0	-0.2	-0.1	-0.2	-0.2	0.0	0.0
Post-Benchmark		1.9	1.9	2.0	1.0	1.1	1.1	1.5	NA	1.4	1.7	NA	1.5	1.7	1.5	1.6	NA	0.5
Soil Type A or B		0.5	0.5	0.4	0.3	0.3	0.4	0.3	0.2	0.2	0.3	0.1	0.3	0.2	0.3	0.3	0.1	0.1
Soil Type E (1-3 stories)		0.0	-0.2	-0.4	-0.3	-0.2	-0.2	-0.2	-0.1	-0.1	-0.2	0.0	-0.2	-0.1	-0.2	-0.2	0.0	-0.1
Soil Type E (> 3 stories)		-0.4	-0.4	-0.4	-0.3	-0.3	NA	-0.3	-0.1	-0.1	-0.3	-0.1	NA	-0.1	-0.2	-0.2	0.0	NA
Minimum Score, S_{MIN}		0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.2	1.0

FINAL LEVEL 1 SCORE, $S_{L1} \geq S_{MIN}$:

EXTENT OF REVIEW
Exterior: ☐ Partial ☐ All Sides ☐ Aerial
Interior: ☐ None ☐ Visible ☐ Entered
Drawings Reviewed: ☐ Yes ☐ No
Soil Type Source:
Geologic Hazards Source:
Contact Person:

LEVEL 2 SCREENING PERFORMED?
☐ Yes, Final Level 2 Score, S_{L2}: ☐ No
Nonstructural hazards? ☐ Yes ☐ No

OTHER HAZARDS
Are There Hazards That Trigger A Detailed Structural Evaluation?
☐ Pounding potential (unless $S_{L2} >$ cut-off, if known)
☐ Falling hazards from taller adjacent building
☐ Geologic hazards or Soil Type F
☐ Significant damage/deterioration to the structural system

ACTION REQUIRED
Detailed Structural Evaluation Required?
☐ Yes, unknown FEMA building type or other building
☐ Yes, score less than cut-off
☐ Yes, other hazards present
☐ No
Detailed Nonstructural Evaluation Recommended? (check one)
☐ Yes, nonstructural hazards identified that should be evaluated
☐ No, nonstructural hazards exist that may require mitigation, but a detailed evaluation is not necessary
☐ No, no nonstructural hazards identified ☐ DNK

Final Score Generation and Importance

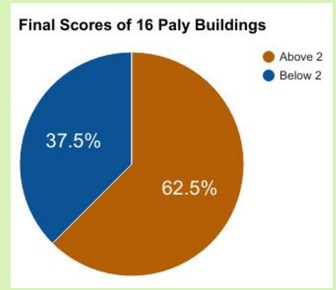
After completing the collection form, **Score Modifier** were used to calculate a **Final (S) score**. The Score Modifiers give negative "points" for characteristics that make the building more hazardous, and positive points for characteristics that improve the seismic performance. The Final score is an estimate of the building's collapse probability in the event of an earthquake.

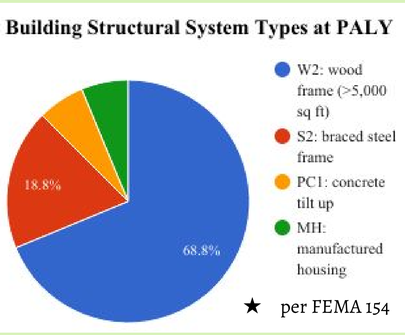
A Final Score of 2 means that there will be a 1 in 10^2 chance that the building will collapse. If a building has a **Final Score of 2 or lower,** that building will be considered **potentially hazardous**.

Building irregularities, soil type, geological hazards (landslides & surface rupture), the building type, and the year built, all contributes to the propensity of a building to collapse.

DATA ANALYSIS AND RESULTS

Building Name	Final Score
100: Art	1.7
200: English	2.3
300: General Education	2.3
400: Foreign Language	2.3
500: Library	2.3
600: Student Center	2.3
700: PE rooms	2.3
800: Social Science/Math	3.0
900: Industrial Shops	1.8
1000: Woodshop	1.6
1700: Science	3.7
Portables	1.6
Main Office	0.9
Haymarket Theatre	0.6
Media Arts Center	3.0
Performing Arts Center	3.0





There are 16 Data Collection sheets in total with detailed information on each building.

A new Score Modifier, "California Division of the State Architect Review", was introduced to the data collection form as a positive score of 0.5 in consideration of the Field Act. It is a significant Score Modifier to include, giving the buildings a more accurate score of their seismic resistance.

After collecting and analyzing the data, 6 out of 16 buildings require further review (by an experienced earthquake engineer) to determine if they are seismically hazardous, since their Final Score is below 2.

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